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NETWORKED INFORMATION GATHERING IN STOCHASTIC SENSOR NETWORKS COMPRESSIVE SENSING, ADAPTIVE NETWORK CODING AND ROBUSTNESS

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14. ABSTRACT
This project has studied networked information gathering, spanning from sensing to processing to communications. The first main thrust was devoted to building a deep understanding of efficient multicast compressively sampled signals from a source to many receivers, over lossy wireless channels. Based on extreme value theory, the network outage is characterized in terms of key system parameters, including the erasure probability, the number of receivers and the sparse structure of the signal, for both cases where the transmitter may or may not be capable of reconstructing the compressively sampled signals. The second thrust focused on the fundamental Doppler sensing capability in a networked radar system. This work has taken some initial steps to develop a novel model in which each radar employs Doppler processing to eliminate clutters from its received signal and decision fusion is carried out across multiple radars for detection. With this model, the optimal detection decision rule is derived for maximizing the detection probability subject to a certain false alarm probability.

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Accomplishments: This project has considered a radar system and studied networked information gathering, spanning from sensing to processing to communications. The first main thrust was devoted to building a deep understanding of efficient multicast compressively sampled signals from a source to many receivers, over lossy wireless channels. Based on extreme value theory, the network outage is characterized in terms of key system parameters, including the erasure probability, the number of receivers and the sparse structure of the signal, for both cases where the transmitter may or may not be capable of reconstructing the compressively sampled signals. It is shown that when the transmitter can reconstruct the compressively sensed signal, the strategy of using network coding to multicast the reconstructed signal coefficients can reduce the network outage significantly.

The second thrust has focused on networked radar systems for battlefield surveillance applications. In particular, the fundamental Doppler sensing capability in a networked radar system remains largely unexplored, especially when information fusion is employed across radars. This work has taken some initial steps to fill this void by developing a novel model in which each radar employs Doppler processing to eliminate clutters from its received signal and decision fusion is carried out across multiple radars for detection. With this model, the optimal detection decision rule is derived for maximizing the detection probability subject to a certain false alarm probability. Further network coverage problems based on this model are investigated.

Archival publications (published) during reporting period:

1. Chandrashekhar Thejaswi P. S., Tuan Tran, and Junshan Zhang: “When compressive sampling meets multicast: Outage analysis and subblock network coding”. INFOCOM 2011: 3047-3055
2. Chandrashekhar Thejaswi P. S., Amir Bennatan, Junshan Zhang, A. Robert Calderbank, and Douglas Cochran: “Layered Coding for Interference Channels With Partial Transmitter Side Information”. IEEE Transactions on Information Theory 57(5): 2765-2780 (2011)

3. Xu Chen, Brian Proulx, Xiaowen Gong, and Junshan Zhang: “Social trust and social reciprocity based cooperative D2D communications”. MobiHoc 2013: 187-196
4. Xiaowen Gong, Junshan Zhang, Douglas Cochran, and Kai Xing: “Barrier coverage in bistatic radar sensor networks: Cassini oval sensing and optimal placement”. MobiHoc 2013: 49-58
5. Xiaowen Gong, Junshan Zhang, and Douglas Cochran: “When target motion matters: Doppler coverage in radar sensor networks”. INFOCOM 2013: 1169-1177